July 22, 2013

A Review of JAS-D-13-0160

Title: Ensemple Transform Adjoint Method for Adaptive Observations
Authors: Y. Zhang et al.
Recommendation: Rejection

- General comments

  This paper proposes an ensemble transform adjoint method method (ETA) for adaptive observations. By applying the proposed method and the traditional ensemble transform method (ET) to the 2011 Irene hurricane case study, the authors demonstrate that the proposed method outperforms the ET method.

  However, the proposed method has a fundamental flaw as the pseudo inverse of the ensemble-estimated covariance does not consider the spurious sample errors (Hamill et al., mwr,2001) . In addition, I do not see the any significant difference of the sensitivity analysis for adaptive observations using ETA and ET methods. Finally, the paper is not well-written, and hard for readers to follow. Overall, my conclusion is that this work does not exhibit enough scientific merit to justify its publication, so I recommend that the paper be rejected.

- Major points

  i. The key point of the paper is that the authors introduce the pseudo inverse for the ensemble-estimated covariance (Eq. (14)), since the ensemble-estimated covariance is rank-deficient due to the limited ensemble available in practice. Similar to the ensemble Kalman filter (EnKF) data assimilation, the ensemble-estimated covariance contains spurious sampling errors. The details of the spurious sampling errors could be found in Hamill et al. (2001). Generally speaking, the ensemble-estimated covariance is only robust within certain distance (which is also called impact radius), and it is dominant of sampling errors beyond the impact radius. In practice, the EnKF uses the covariance localization to account for sampling errors (Hamill et al. 2001). Without covariance localization, the EnKF fails to produce the optimal combination between model forecasts and observations. Thus, the sensitivity analysis for adaptive observations would not produce a robust information for the forecast error reduction, since the covariance was contaminated by the ensemble sampling errors.

  ii. On P13L296, the authors assumes the analysis covariance $\mathbf{A}$ is a diagonal matrix. The assumption is highly unrealistic, especially for the sensitivity analysis for adaptive observations. The off-diagonal matrix of $\mathbf{A}$ contains the correlation information between one location to others, so it is critical for the adaptive observations. I would recommend the authors to use the analysis covariance from the EnKF. The ensemble sensitivity analysis for adaptive using EnKF has been successfully used for the mid-latitude cyclones (Chang et al. 2013) and the hurricanes (Xie et al. 2013).

REFERENCES

Chang, E., M. Zheng, and K. Raeder, 2013: Medium range ensemble sensitivity analysis of two extreme pacific extratropical cyclones. *Mon. Wea. Rev.*, **141**, 211–231.

Hamill, T. M., J. S. Whitaker, and C. Snyder, 2001: Distance-dependent filtering of background error covariance estimates in an ensemble Kalman filter. *Mon. Wea. Rev.*, **129**, 2776–2790.

Xie, B., F. Zhang, Q. Zhang, J. Poterjoy, and Y. Weng, 2013: Observing strategy and observation targeting for tropical cyclones using ensemble-based sensitivity analysis and data assimilation. *Mon. Wea. Rev.*, **141**, 1437–1453.